Fabrication and functionalization of nanoribbon networks from arbitrary two-dimensional materials

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A novel route towards single-crystalline nanoribbon networks from arbitrary two-dimensional (2D) materials is presented. The method is relying on the fact that small organic molecules like parahexaphenyl (6P) are growing by hot-wall epitaxy as crystalline nano-needles along discrete directions of the 2D substrates [1,2]. The needle directions can be obtained by power-spectral density analysis of atomic-force microscopy (AFM) images. The needles are usually several micrometers long, having a uniform height of a few nanometers and a nearly constant width of several ten nanometers. They are frequently forming self-assembled networks on graphene, hexagonal boron nitride, and transition metal dichalcogenides like MoS_2, WS_2, and WSe_2. These networks are used as masks for reactive ion etching leaving a nanoribbon (NR) network of the 2D substrate material behind [3]. Raman spectroscopy is used to demonstrate the structural integrity of the NR networks. These nanoribbon networks can be utilized for field effect transistor devices showing large mobilities and high ON currents.

Further we demonstrated that the NR networks can be functionalized via photo-induced edge-specific nanoparticle decoration [3,4]. This route is particularly effective for functionalization of WSe_2 NR with Ag nanoparticles. AFM and scanning electron microscopy reveal a narrow size distribution of the Ag nanoparticles which are exclusively arranged along the NR edges. The nanoparticle density can be tuned by the laser fluence [4].

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